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ABSTRACT

A project was conducted at Spokane Community College to identify the electronics competencies required of entry-level employees in several occupations. The methodology included surveying advisory committee members and faculty members representing a variety of vocational programs at the college, and direct contact with industry. Through these efforts, the need for a peripheral electronics curriculum has been identified, a review of electronics textbooks has been completed, and the competencies of today's vocational fields have been compared to those required five years ago. Evaluation of information gained through the survey suggested that the various vocational disciplines might be separated into two broad categories--servicing and non-servicing. The distinction is based on whether or not an employee is required to analyze, maintain, or repair electronics-based equipment used in that vocation. It appeared that representatives of the vocations identified as servicing support the need for certain electronics competencies to be developed during the training period. The text search and evaluation seem to indicate that the written materials used by many electronics technician programs may be too in-depth for satisfactory use in curriculum developed to meet competency levels described. The results of this study may be used to develop curriculum packages to acquaint students in various fields with electronics. (A list of the technology requirement ratings of various occupations is included in the report.) (KC)

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IDENTIFICATION OF ELECTRONICS COMPETENCIES IN VOCATIONAL PROGRAMS

FINAL REPORT

Project No. 84-AWF(235)NB

Curriculum Development Project
Conducted Under Public Law 94-482

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Washington State Commission for Vocational Education

FINAL REPORT
PROJECT NO. 84-AWF(235)NB

IDENTIFICATION OF ELECTRONICS COMPETENCIES IN VOCATIONAL EDUCATION

CURRICULUM DEVELOPMENT PROJECT
CONDUCTED UNDER
PUBLIC LAW 94-482

The project reported herein was performed pursuant to a grant from the Research Coordinating Unit of the Washington State Commission for Vocational Education. Contractors undertaking such projects under the Commission for Vocational Education sponsorship are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Commission for Vocational Education position or policy.

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DECEMBER 20, 1984

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Preface

In 1984, Spokane Community College was awarded a contract by the Washington State Commission for Vocational Education (WSCVE) entitled, "Identification of Electronics Competencies in Vocational Programs."

The objective of the project was to identify the electronics competencies required of employees, and particularly, prospective employees entering into one of any number of vocational experiences. To accomplish the objective of the project, certain faculty members of Spokane Community College undertook a search of expected competencies in electronics through communication with advisory committee members, faculty members representing the variety of vocational programs at Spokane Community College, and through direct contact with industry at large.

Through these cumulative efforts the needs for peripheral electronics curriculum have been identifed, a review of electronics-related textbooks has been accomplished, and the competencies of today's vocational spectra has been comarped to the competencies required approximately five years ago.

Introduction

Today's emphasis on high technology has effected virtually every vocational discipline to some degree or another. Historically, the need to know electronics concepts, if the need existed at all, was something that developed with experience within the discipline. Within the past five years the electronics explosion has made the need more apparent and has made the various vocational programs more in need of some level of electroics training within the curriculum.

This grant-supported project was undertaken to identify specifically where these electronics competencies were required, and to what competency level the new-entry worker should achieve in the educational program.

Information presented in this project was obtained from extensive surveying of advisory committee members representing virtually all vocational programs at Spokane Community College, by contacts within the faculty structure at Spokane Community College, and through communication with representative businesses and companies within the local geographical area. In addition to these inputs, a search and evaluation of textbooks for the electronics disciplines was accomplished.

The results of these identified activities are presented herein.

Text

A survey instrument was developed for distribution to advisory committee members. This survey is attached as Appendix A. No attempt was intrinsically made by project members to identify which vocations had electronic skill needs and which did not, rather all advisory com-

mittees were included. Because of this some committee members, not recognizing any need, did not respond to the survey. Others did not perceive a need but did respond to the survey in one of three ways:

a) Returned the survey without completing it.
b) Returned the survey completed in such a way that indicated the member did not understand the intention of the survey.
c) Returned the survey completed and indicating no need to know any electronic competencies.

Since this project was one of identification and not of evaluation, responder reasoning was not considered but simply tabulated and presented herewith.

A total of seven hundred fifty (750) surveys were sent to committee members representing eighty-six (86) advisory committees. Two hundred eleven (211) were returned which included two hundred one (201) from identified committee members and ten (10) from non-identifiable committee members. Sixty-two (62) of the eighty-six (86) committees originally contacted had at least one member respond to and return the survey. Only one committee, Office Machine Repair, had 100% membership participation.

The summarization of requirements as seen by committee members is presented on page 3 as Table 1. It should be noted that the summary may represent the input of only one committee member or it may represent the input of several members of a committee. A "1" has been assigned to represent a "needs to know," a "2" represents a "nice to know," and a "3" represents a "does not need." Only committees with determinable scaling are presented.

TABLE 1
SUMMARY OF REQUIREMENTS

Discipline	Components	Theory	Tools	Test Equipment
Accounting	3	3	3	3
Advanced Life Support	3	3	3	3
Air Conditioning, Refrigeration and Heating	1.5	2.5	1	2.0
Aircraft	1.5	2	1	1.5
Appliance Repair	2	2.5	1	1.5
Architectural Technology	2.5	3	3	3
Automotive	1.5	2	1	1.5
Bank Teller	3	3	3	3
Body and Fender	2.5	2.5	1.5	3
Camera Repair	1	1	1	1
Cardiopulmonary Technician	3	3	3	3
Carpentry	3	3	3	3
Cashier/Checker Training	3	3	3	3
Cosmetology	3	3	3	3
Data Processing	3	3	3	3
Dental Assisting	2.5	3	1	2.5
Display Designer	3	3	2	3
Early Childhood Education	3	3	3	3
Farm Machinery	1.5	1.5	1.5	1.5
Fashion Merchandising	3	3	3	3
Fire Science	3	3	3	3
Fluid Power	2	2	1.5	1.5
Gerentology	3	3	3	3
Heavy Equipment/Diesel	2	2.5	1.5	1.5
Industrial Electricity	1	1	1	1.5
Insurance Specialist	3	3	3	3
Law Enforcement	3	3	3	3
Library Technician	3	3	3	3
Machine Shop	2	2.5	2	2.5
Mechanical Engineering Technology	1.5	2	1.5	1.5
Medical Records Technician	3	3	3	3
Mobile Home and Trailer Repair	2.5	2.5	1	2.5
Musical Instrument Repair	1	1.5	2	1
Natural Resources	3	3	3	3
Negotiation and Mediation	3	3	3	3
Nursing	3	3	3	3
Office Machine Repair	1.5	1.5	1	2
Optometric Technician	3	3	3	3
Photography	2	3	1	3
Printing	3	3	2	3
Prosthetic Technician	3	3	3	3
Real Estate	3	3	3	3
Respiratory Therapy	1.5	3	2.5	3
Water Resources	1.5	1.5	1	1.5
Secretarial Sciences	2	3	2	3
Small Engine Repair	1.5	2.5	1	1.5
Social Education	3	3	3	3
Software Engineering	1	1	1	1
Special Education and Rehab.	1.5	2	-	-
TV and Radio Production	2	2	1.5	2
Upholstery	3	3	2	3
Watch Repair	1.5	2.5	1.5	1.5
Welding	1.5	2.5	1	1.5

The temptation to evaluate the reasoning is strong. For example, Secretarial Sciences indicates a "nice to know" for components and tools but "do not need" for theory and test equipment. Appliance Repair indicates a scaling between "nice to know" and "does not need" for theory. At face, it would seem the opposite would be true. Another example of interest is found in comparing similar disciplines. Specifically, Respiratory Therapy and Cardiopulmonary Technician are similar and yet the first indicates some need to know while the latter indicates no need to know. Again, the reasons for the scaling is not at point in this project. The examples just cited are to perhaps illustrate the inconsistencies found which probably reflect, to some extent, the understanding that each respondent had concerning the survey instrument or needs in that area.

In review of the tabulated information, the project members have been able to identify those disciplines which have shown a need for electronics skill competencies. However, in some instances, the results are not clearly defined. In these cases, contact with faculty members for clarification have been made.

The same instrument, Appendix A, was used to gather input from faculty members at Spokane Community College. The return on this survey was approximately 10% of the faculty. This response in general presents insufficient data to evaluate reliably. On specific input, however, faculty members returning the survey did concur with the input of the advisory committee representing their particular discipline. As an example, the survey returned by one of the automotive technician faculty indicated a nearly parallel opinion to the surveys received fromt he advisory committee for this program. In another example, the survey returned by a Cosmetology instructor echoed the results of the survey of the Cosmetology advisory committee.

After evaluating the total advisory committee/faculty survey returns, it became apparent that the various vocational disciplines might be separted into two broad categories - servicing and non-servicing. The servicing category would include such programs as automotive technician, fluid power, office machine repair, small engine repair, industrial electricity, and other such programs. Non-servicing would include programs such as secretarial sciences, library technician, real estate, law enforcement, and other similar vocational areas. The defining factor stems from whether or not an employee within a given vocation is requried to analyze, maintain, or repair electronics based euqipment used in that vocation. A specific example might be that of an employee of the law enforcement vocation. While it is generally know that this voctional field uses considerable electronics based equipment, the job description of individuals within the vocation usually does not include the analysis, maintenance, or repair of such equipment and, therefore, the identification of this vocational as non-servicing. On the other hand, an employee of the automotive technician industry is faced with an onslaught of electronic based equipment so completely integrated with the mechanical system that the job description will mandate the ability to analyze, maintain, or repair such equipment and thus the classification as servicing.

In retrospect, all individuals involved, either formally or casually, in this survey acknowledged that electronics-based instrumentation has had significant influence in all ovcational areas. However, the concluding remarks of this report shall incorporate only generalized statements pertaining to disciplines that may be categorized as servicing.

As a final, but integral, portion of this project a text evaluation was accomplished. The grade level evaluation was based on the Frye index. The average grade level for those texts evaluated is 16.17 where 17+ was arbitrarily assigned a value of 18 for the average computation. The specific texts evaluated with grade level and comments are attached as Appendix B.

Conclusion

In review of the information presented in Table 1, Summary of Requirements, some relevant information may be found. Some information is quite surprising, especially in noting programs that indicate a competency need that might not be obvious to curriculum developers. A point might be made as example to the "needs to know" rating in all categories of the survey by representatives of the Camera Repair program. Secondly, if one considers the complexity of some of today's modern appliances, surprise might be registered at the moderate indication of "nice to know" from representation of the Appliance Repair discipline.

It would appear that the overall opinions of the representatives of the various vocations identified within this project as servicing support the need for certain electronics competencies to be developed during the training period. There is clearly a distinction in the competency level expected of these training for a servicing career field when compared to competency levels of those training specifically for employment as an electronics technician. As pointed out to the project members in several interviews, in the servicing fields the ability to interact with the electronic systems is a part of the job and not the whole of it.

It is the finding of this project team that there are many vocational disciplines having electronic skills competency needs. These disciplines have been identified within this report. The competency level appears to be that of component recognition with basic understanding of function, an elementary ability to use Ohm's law in understanding simple series and/or parallel circuits, the ability to use basic test equipment such as voltmeters, ammeters, ohmmeters, and oscilloscope and to understand the indications to the point that an electronic problem may be traced to at least a module level. The skills developed need to provide the ability to use proper tools associated with electronic circuity, the ability to solder or unsolder wires, components, or plugs, and the ability to remove faulty modules (in some instances components) and install new units and evaluate for proper operation.

The text search and evaluation accomplished as a part of this rpoject tends to indicate that the written materials used by many electronics technician programs may be too in-depth and technicial in their approach to be satisfactory for use within curriculum developed for the competency levels suggested above. It may be more practical to use written material that has been instructor developed, or perhaps, texts that follow a self-paced concept.

It is expected that the results of this project will be used to identify the areas having electronics curricula needs so that future projects will develop satisfactory curriculum packages that will enable vocational programs to more effectively prepare the student to smoothly enter into the vocations of today's high technology.

APPENDIX A

PLEASE RATE EACH ITEM

	DOES NOT NEED TO KNOW	WOULD BE HELPFUL TO KNOW	NEEDS TO KNOW
1. Resistor			
2. Capacitors			
3. Coil			
4. IC			
5. Transistor			
6. Diode			
7. Switch			
8. Fastener Size (6-32, 10-24, 000 etc.)			
9. Screw Type (pan head, flat head, etc.)			
10. Displays LED - LCD Lamps			
11. Wire (current capacity)			
12. Transformer			
13. Variable Resistors			
14. Thermistors			
15. Voltage Variable Resistors			
16. Batteries			

PLEASE RATE EACH ITEM

THEORY	DOES NOT NEED TO KNOW	WOULD BE HELPFUL TO KNOW	NEEDS TO KNOW
1. Ohm's Law			
2. Power Calculations			
3. Color Code			
4. Reactance			
5. Series Circuits			
6. Parallel Circuits			
7. Kirchhoff's Law			
8. Time Constants			
9. Variable Voltages (AC)			
10. Transformer Action			
11. R M S Meaning			
12. Tuned Circuits			
13. Circuit Analysis - Analog (a) Schematic Reading (symbols)			
(b) Electrical			
(c) Functional (block diagrams)			

PLEASE RATE EACH ITEM

THEORY (continued)	DOES NOT NEED TO KNOW	WOULD BE HELPFUL TO KNOW	NEEDS TO KNOW
14. Circuit Analysis - Digital			
15. Analysis of Microprocessors (a) Schematic Reading (symbols)			
(b) Electrical			
(b) Functional (block diagrams)			
16. Vacuum Tube Theory			
17. Semi-conductor Theory			
18. Digital Theory			
19. Varicap Diodes			
20. Power Supply (a) Regulated			
(b) Unregulated			
21. Integrated Circuits (a) Digital			
(b) Linear			
22. Operational Amplifiers			
23. Other			

PLEASE RATE EACH ITEM

TOOLS	DOES NOT NEED TO KNOW	WOULD BE HELPFUL TO KNOW	NEEDS TO KNOW
1. Needle Nose Pliers			
2. Side Cutters			
3. Soldering Iron			
4. Soldering Gun			
5. Screwdriver			
6. Nut Driver (socket set)			
7. Wire Stripper			
8. Wire Wrap Tool			
9. Wire Unwrap Tool			
10. Other			

PLEASE RATE EACH ITEM

EQUIPMENT TO USE	DOES NOT NEED TO KNOW	WOULD BE HELPFUL TO KNOW	NEEDS TO KNOW
1. VOM			
2. VTVM			
3. DMM			
4. Oscilloscope			
5. Signal Generator			
6. Wheatstone Bridge			
7. Voltmeter DC - AC			
8. Ammeter DC - AC			
9. Ohmmeter			
10. Frequency Counter			
11. Amprobe			
12. Digital Probes			
13. Hydrometer			

APPENDIX B

READABILITY SUMMARY SHEET

Textbook & Author (Introductory Electronics)	Average Grade Level According to Frye Index	Comments
APPLIED ELECTRONIC COMMUNICATIONS Robert Kellejiah--SRA	17+	Complex sentence structure increases difficulty. Technical vocabulary increases difficulty Helpful organization of chapters. Learning objectives clearly stated for each chapter. Helpful chapter introduction, conclusion, and problems to solve.
MICROPROCESSORS & DIGITAL SYSTEMS Douglas V. Hall--McGraw-Hill	13.3	Unhelpful & unattractive chapter organization and appearance. Little ongoing practice available. Size of book awkward and inconvenient. Helpful review questions and problems for each chapter. Introduction and competencies for each chapter not clearly marked.
BASIC ELECTRONICS Grob--McGraw-Hill	16	Excellent illustrations; self checking practice throughout chapter is helpful. Good organization of chapters, use of color for headings. Terms needed to know are clearly noted at chapter beginning. Good cross reference terms to chapter content.
ELECTRONIC MEASUREMENTS Kantrowitz, Kouseurou, Zucker--Prentice-Hall	17	Introduction, summary and review questions helpful; objectives and terms not clearly stated.
SOLID STATE DEVICES AND APPLICATIONS F. Driscoll, R. Couglin--Prentice-Hall	17+	Problems to work at end of each chapter; chapter headings listed at first of chapter not objectives; helpful appendixes.

Textbook & Author (Introductory Electronics)	Average Grade Level According to Frye Index	Comments
ELECTRONIC COMMUNICATION. Robert L. Shrader--McGraw-Hill	15.6	Helpful check-up quizzes (self-checking) and commercial licensing questions which have answers cross-referenced to chapter content.
FUNDAMENTALS OF ELECTRONIC DEVICES David A. Bell--Reston Pub. Co.	13.6	1975-out-of-date?! Chapter glossary of terms helpful but would be more helpful at the beginning of a chapter, not the end; helpful review questions; brief introduction.
DIGITAL ELECTRONICS W. H. Gothmann--Prentice-Hall	16.7	Excellent "Useful Reference Data" chart. Good end-of-chapter problems and summary; thorough glossary; no introduction or stated chapter objectives.
ELECTRONIC CIRCUIT BEHAVIOR Daniel L. Metzger--Prentice-Hall	17+	Informational appendixes; end-of-chapter summaries are organized in helpful list form; key words in darkened print within chapter sections; helpful end-of-chapter questions and problems.
BASIC ELECTRICITY - A TEXT-LAB MANUAL Paul B. Zbar--McGraw-Hill	15	Good section on safety; objectives clearly stated at beginning of chapter. Paperback awkward, larger size; helpful self-test and summary list.
(Introductory Electronics Mathematics)		
BASIC MATHEMATICS FOR ELECTRONICS Cooke, Adams, Dell--McGraw-Hill	16.7	A) Student would need to have completed the following high school math classes to succeed with this text: 1. Algebra; 2. Geometry; 3. Algebra-Trigonometry. Would be very helpful if pre-calculus had also been taken. B) The mathematical notations are different from those most commonly used in most secondary math texts.